AD-A185 071 FULL FIELD VISUALIZATION OF SURFACE AND BULK ACOUSTIC WAVES USING HETEROD..(U) JOHNS HOPKINS UNIV BALTIMORE MD DEPT OF MATERIALS SCIENCE AND.. J W WAGNER ET AL. 1/1

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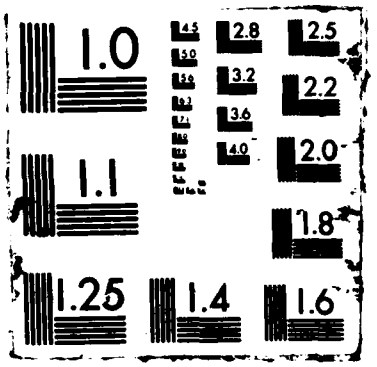
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ANNUAL SUMMARY REPORT

for

1 December 1986 through 15 September 1987

for

Contract N00014-82-K-0741-P0004
R&T Number 4126813

FULL FIELD VISUALIZATION OF SURFACE AND BULK ACOUSTIC WAVES USING HETERODYNE HOLOGRAPHIC INTERFEROMETRY

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ABSTRACT

The objective of this research has been to apply optical holographic techniques coupled with electronic signal and image processing to provide quantitative, full field measurements of acoustic wave disturbances. Building on work performed previously at Johns Hopkins and under contract to the Office of Naval Research, this program has sought to establish the limits of sensitivity with which surface acoustic waves might be measured and mapped. In addition, an effort to extend heterodyne holographic measurements to the examination of acoustic energy flow in optically transparent bulk materials has begun.

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The objective of this research has been to apply optical holographic techniques coupled with electronic signal and image processing to provide quantitative, full field measurements of acoustic wave disturbances. Building on work performed previously at Johns Hopkins and under contract to the Office of Naval Research, this program has sought to establish the limits of sensitivity with which surface acoustic waves might be measured and mapped. In addition, an effort to extend heterodyne holographic measurements to the examination of acoustic energy flow in optically transparent bulk materials has begun.

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Two program objectives were to be pursued during this first contract year - 1) establish film limitations in holographic interferometric measurements and 2) produce tomographic display of fixed refractive index variations in transparent media. Through three quarters of this contract year, work towards these objectives has proceeded nearly on schedule.

Film Limitations on Measurement Sensitivity

Silver halide films used for holographic recording have sufficiently small grain sizes so as to permit high resolution recording in excess of 1000 lines/mm (2000-3000lpm are typical). Yet measurements using holographic interferometry, and especially heterodyne holographic interferometry, claim sensitivity to levels well below the film resolution. In the case of heterodyne holographic interferometry, sensitivity claims are made to nearly 2.5 Angstroms - some three orders of magnitude smaller than the 0.5 micron (at 2000 lpm) film resolution. The link between film and measurement resolution is not well established.

In attempting to define measurement limits imposed by film, however, an unanticipated source of phase noise was encountered. This noise source arose from the differences in optical components used in high speed recording compared with those used in the holographic readout system. Thus when a hologram, recorded using one set of optics, was reconstructed and analyzed using separate components, it became impossible to distinguish between optical path changes introduced by surface acoustic displacements and those caused by variations in optical components.

To help eliminate this source of measurement error, both the recording and readout systems were combined using the same optical components. The beam diameter of the pulsed laser used for holographic recording was reduced to the same size as that of the cw argon ion laser used during reconstruction and analysis. The increase in energy density resulting from the reduction in beam diameter induced nonlinear behavior, and damage in some cases, in some of the optical materials used in the components. The recording and analysis systems have been reconfigured in order to eliminate these errors as well. It is anticipated that preliminary data on film limitations should be in hand by the end of the contract year.

Optical Tomography

Progress has been more readily made toward this second program objective. Computer algorithms for tomographic image reconstruction have been obtained as part of the

Donner library produced by the University of California at Berkely. Several of the routines have been implemented on a microVax II computer. In addition, this computer has been interfaced to a Vicom digital image processing system. Tomographic reconstruction of a tinted, square plexiglas rod in an index matching fluid have been made based on optical absorption variations. Hardware modifications are underway to permit the collection of data necessary to produce images based on refractive index variations. In subsequent work we intend to replace the object with a hologram to examine the feasibility of extracting sufficient data from holographic images to produce tomographic reconstructions.

OFFICE OF NAVAL RESEARCH

PUBLICATIONS / PATENTS / PRESENTATIONS / HONORS REPORT

FOR

1 OCTOBER 1986 through 30 SEPTEMBER 1987

FOR

CONTRACT N00014-82-K-0741-P0004
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PAPERS SUBMITTED TO REFEREED JOURNALS
(Not yet published)

PAPERS PUBLISHED IN REFEREED JOURNALS

Wagner JW, Spicer JB, Theoretical noise-limited sensitivity of classical interferometry, Accepted for publication, J Optical Society of America B.

Wagner JW, High resolution holographic techniques for visualization of surface acoustic waves, Materials Evaluation 44(10), 1238-1243 (1986).

BOOKS (AND SECTIONS THEREOF) SUBMITTED FOR PUBLICATION

BOOKS (AND SECTIONS THEREOF) PUBLISHED

PATENTS FILED

PATENTS GRANTED

INVITED PRESENTATIONS AT TOPICAL OR SCIENTIFIC/TECHNICAL SOCIETY CONFERENCES

Wagner JW, High speed heterodyne holographic interferometry, 20th Annual Convention of the International Metallographic Society, Symposium on The Characterization of Advanced Materials (Monterey, CA), July 28, 1987.

Wagner JW, Full field mapping of transient surface acoustic waves using heterodyne holographic interferometry, Ultrasonics International 87 (London, UK), July 1987.

Wagner JW, High speed applications of heterodyne hologram interferometry, SPIE O-E/Lase 87 (Los Angeles, CA) January 1987, SPIE Proceedings Vol. 746.

HONORS/AWARDS/PRIZES

GRADUATE STUDENTS SUPPORTED UNDER
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Louis C. Phillips

Michael J. Ehrlich

POSTDOCTORALS SUPPORTED UNDER
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